Quarterly Report – Public Page

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Project Title: *Augmenting MFL Tools with Sensors That Assess Coating Condition*

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Progress to date:

The goal of this project is to add sensors for coating assessment to a typical in-line inspection tool. These sensors will help pipeline owners assess the general health of the external coating that is protecting their pipeline system. External coatings are routinely used to protect transmission pipelines from corrosion; however these coatings degrade over time and can be damaged by outside forces including earth movement and excavation equipment. To detect metal loss corrosion defects, transmission pipeline operators often inspect their pipelines with magnetic flux leakage (MFL) in-line inspection tools. While most defects detected are benign to the operation of the pipeline, the few metal loss defects that affect the integrity of the pipeline remain a concern. Unfortunately, MFL corrosion surveys only find the result of the problem (corrosion), not the source of the problem (coating failure). Stress corrosion cracks (SCC), which occur at coating disbonds, can be detected using ultrasonic in-line inspection technology. Unfortunately, the cost to inspect for SCC is high, and inspections are usually conducted on pipelines with a higher probability of cracking based on soil models, cathodic protection assessment, bellhole inspections, and related data. Accurate detection of disbonded coating can help to indicate future conditions that may lead to the corrosion of the pipeline. The sensors that will be developed on this project would not add substantial cost or complexity to a normal MFL survey. The technology could help justify reinspection intervals based on the fact that the corrosion threat has been properly addressed (MFL in-line inspection) and the threat mitigation method (the coating) has been verified.

In this first quarter, we have identified the primary electromagnetic acoustic transducers (EMAT) sensor configurations that will be used for the remainder of this project. Both shear horizontal (SH) and Lamb-wave EMATs have the potential to detect disbonded and missing coating. These types of EMATs will allow for the generation of a large variety of guided-wave modes, which is desirable in order to account for the effects of different types and thicknesses of coatings. Prior PRCI results have focused on a Lamb-wave EMAT. The detection of disbonds was shown to be feasible for some but not all coating types; analysis of wave propagation and attenuation was

needed to understand the capability and limitations the implementation. Analytical and numerical modeling has begun and it has been shown that there are at least three different features for the identification of disbonded regions: velocity variations, amplitude variations, and edge reflections. Dispersion and wave structures have been shown for the first circumferential SH mode in the low frequency range, with results for higher frequencies and for Lamb modes to be added in the future.

Both SH and Lamb-wave EMATs can be incorporated into MFL technology with no foreseen difficulty. Low frequencies result in larger EMATs and therefore the lowest possible frequency will be dictated by the amount of space present in the MFL or other ILI tool. High frequencies generally exhibit high attenuation though this may be a desirable feature for this study. Therefore the optimal frequency may also depend upon the size of the pipe being inspected. Numerical modeling results have been shown that support the potential of EMAT-like loading to detect disbonds in protective coating layers.